SECTION 1

INTRODUCTION

1.1 PURPOSE AND SCOPE

The Ernest O. Lawrence Berkeley National Laboratory (Berkeley Lab) has prepared this Corrective Measures Study (CMS) Report in accordance with the terms of its Hazardous Waste Facility Permit, issued by the California Environmental Protection Agency Department of Toxic Substances Control (DTSC) (DTSC, 1993). The requirements for completing the CMS and preparing this CMS Report were based on the provisions of the Permit and the guidance provided in the USEPA RCRA Corrective Action Plan (USEPA, 1994). Those requirements were incorporated into the CMS Plan (Berkeley Lab, 2002a), which was submitted to the DTSC on May 24, 2002, and approved by the DTSC on June 18, 2002 (DTSC, 2002).

The primary purpose of the CMS is to provide the information necessary to support the DTSC in the selection of remedies to be implemented at Berkeley Lab, so that risks to human health and the environment are eliminated, reduced, or controlled. The first step in the CMS consisted of characterizing the risk to human health and the environment. This step was addressed by completing both a Human Health and an Ecological Risk Assessment (HHRA and ERA) (Berkeley Lab, 2003a, 2002b). The risk assessments evaluated potential present and future human health and ecological risks associated with environmental contamination, assuming that no cleanup activities would take place at the site. The results of the risk assessments are summarized in Section 1.3.4.

In order to provide the necessary information to support the DTSC in its decision making process, the CMS Report first screens various corrective measures alternatives that could reduce or eliminate potentially adverse effects to human health or the environment from chemicals of concern (COCs) in environmental media at Berkeley Lab. The CMS Report then compares those alternatives that passed the initial screening process based on a formal evaluation procedure, and recommends which alternatives should be implemented. The report also recommends media-

specific chemical concentrations (Media Cleanup Standards [MCSs]) that corrective measures should ultimately achieve.

Section 1 of this report contains the background information and includes: the purpose for conducting the CMS; a description of the site; an overview of regulatory oversight, a discussion of the Resource Conservation and Recovery Act (RCRA) Corrective Action Process (CAP) at Berkeley Lab; and a description of the CMS process, including the methodology and results of the previously completed risk assessments. Section 2 contains a description of the physiography, geology and hydrogeology of Berkeley Lab. Section 3 presents a detailed description of the methodology used to complete the CMS. MCSs are developed and potential corrective measures alternatives are evaluated for volatile organic compounds (VOCs) (primarily solvents and solvent-related chemicals) in Section 4 and for PCBs in Section 5. Sections 4 and 5 contain a unit-by-unit discussion of the following:

- Physical characteristics, including geology and hydrogeology
- Current conditions, including the magnitude and extent of contamination
- Interim Corrective Measures (ICMs) and/or pilot tests that were implemented
- Proposed Media Cleanup Standards (MCSs) and Points of Compliance (POCs)
- An evaluation of corrective measures alternatives
- Recommendation of corrective measures to implement.

Section 6 provides cost estimates to achieve both risk-based cleanup levels and cleanup levels based on protection of potential future drinking water sources. Section 7 provides National Environmental Policy Act (NEPA) documentation which includes a summary of the proposed RCRA corrective actions at Berkeley Lab and a discussion of their consequences. Supplemental information for this report is provided in Appendices A through J, including **Appendix J** which contains regulatory agency comments and Berkeley Lab responses on the initial Draft CMS Report dated July 2004.

1.2 SITE DESCRIPTION AND OVERVIEW

Berkeley Lab is a multi-program National Laboratory managed by the University of California (UC) for the United States Department of Energy (DOE), with primary funding and oversight provided by the DOE. It is located in the Berkeley/Oakland Hills in Alameda County, California and encompasses approximately 200 acres adjacent to the northeast side of the UC

Berkeley campus **(Figure 1.2-1)**. The western three-quarters of the site are in the city of Berkeley and the eastern quarter is in the city of Oakland. The property consists of 29 parcels that are separately leased to the DOE from the University of California. DOE renews its contract with UC to manage the site every five years, at which times expiring leases are renewed for the five-year term of the contract.

Approximately half the site is developed and half is open space. The developed areas include buildings, paved areas, and landscaped areas. The buildings house laboratories, offices, meeting rooms, and fabrication/maintenance shops that support Berkeley Lab research activities. In addition, the site has a hazardous waste handling facility, a fire station, and a medical clinic. In general, the structures at Berkeley Lab are owned by the DOE. In 2002, there were 110 buildings of conventional construction and 86 trailers and other structures on the site. The site is fenced and access is restricted.

Berkeley Lab is bordered on the west and northwest by private homes and multi-unit dwellings. To the west-southwest are student residence halls, the UC Berkeley campus, and the downtown area of Berkeley. North and northeast of Berkeley Lab are the University's Lawrence Hall of Science, the Space Sciences Institute, and the Mathematical Sciences Research Institute. To the east, the land is mostly undeveloped and includes Tilden Regional Park and open space. The area to the southeast, which is owned by UC, is maintained largely in a natural state and includes UC-Berkeley recreational facilities and the University Botanical Gardens.

Berkeley Lab began operations as an accelerator laboratory in 1931 on the campus of the University of California at Berkeley. In 1939 the Laboratory moved to its current location with the construction of the 184-Inch Cyclotron. The area of the cyclotron building (the original Building 6) and adjacent support shops and laboratories to the north and east of Building 6 formed the core of Berkeley Lab operations throughout the 1940s, and therefore is commonly referred to as "Old Town".

From an initial emphasis on high-energy and nuclear physics, research at Berkeley Lab has diversified to also include material sciences, chemistry, earth sciences, biosciences, environmental sciences and energy sciences. The operation of laboratories and support facilities in support of these types of research activities are the basis for the institutional land use scenario

used to develop the MCSs proposed in this report. Berkeley Lab is in the process of preparing an updated 2004 Long Range Development Plan (LRDP) (Berkeley Lab, 2003b), which will address continuing and future uses and activities as a research institution through 2025. The Land Use Plan, included as part of the LRDP, will include the following three categories of general development zones consistent with current land use at Berkeley Lab:

- Facilities Development Area – research and support activities. Would encompass primarily the already developed central portion of the Lab. The LRDP would promote development on infill and existing building sites and would look to consolidating research activities.
- Vegetation Management Areas – managed landscape, wildland fire, and natural areas. Would be located entirely along the perimeter of the site and would provide an open space buffer to neighboring land uses. Vegetation in these areas would continue to be managed to reduce wildland fire risks. Environmental monitoring structures and access roadways would be allowed in these areas.
- Special Habitat Protection Areas – no regular vegetation management or development is anticipated. Would provide for protection of identified special status species habitats and riparian zones.

As a result of Berkeley Lab's mission as a research facility, many types of chemicals have been used or produced as wastes over the more than 60 years of operation. These include gasoline, diesel, waste oil, polychlorinated biphenyls (PCBs), Freon®, solvents, metals, acids, caustics, and lead- and chromate-based paints. Additionally, radionuclides have been used or produced as waste at Berkeley Lab. Some of these chemicals have been released to the environment.

The principal chemicals that have been detected in the environment at Berkeley Lab are chlorinated VOCs in the soil and groundwater, and PCBs in the soil. The detected VOCs primarily include tetrachloroethene (PCE), trichloroethene (TCE), carbon tetrachloride, 1,1-dichloroethene (1,1-DCE), *cis*-1,2-dichloroethene (*cis*-1,2-DCE), 1,1,1-trichloroethane (TCA), and 1,1-dichloroethane (DCA). Most of these VOCs are solvents (and their degradation products) that were used as degreasers for cleaning equipment at Berkeley Lab. PCB contamination is primarily associated with spilled transformer oils and former waste oil tanks. Other contaminants that have been detected in soil and/or groundwater include petroleum hydrocarbons (in most cases associated with former underground storage tank [UST] sites), semi-volatile organic compounds (SVOCs), polynuclear aromatic hydrocarbons (PAHs), and metals.

1.3 THE RCRA PROCESS AT BERKELEY LAB

Berkeley Lab's Hazardous Waste Handling Facility (HWHF) operates under a RCRA Hazardous Waste Facility Permit. Section 3004(u) of RCRA, as amended by the Hazardous and Solid Waste Amendments (HSWA) and Title 40 of the Code of Federal Regulations (CFR) §264, requires that permits issued after November 8, 1984 address corrective action for all releases of hazardous wastes, including hazardous constituents from any Solid Waste Management Unit (SWMU). Therefore, the Permit requires that Berkeley Lab investigate and address historic releases of hazardous waste and constituents that may have occurred both at the HWHF and at SWMUs throughout the Berkeley Lab site. Berkeley Lab's Environmental Restoration Program (ERP) is responsible for conducting those investigations. The ERP is part of the Environmental Services Group of Berkeley Lab's Environment, Health and Safety (EH&S) Division.

The DTSC is the regulatory agency responsible for enforcing the provisions of Berkeley Lab's Hazardous Waste Facility Permit, including the activities required under the RCRA CAP. Corrective action refers to the activities related to the investigation, characterization, and cleanup of releases of hazardous waste or hazardous waste constituents under RCRA. In July 1993, the DTSC delegated some CAP oversight agency authority and responsibilities at Berkeley Lab to other regulatory agencies. The City of Berkeley was assigned as the lead agency for the technical review of USTs. The San Francisco Bay Region of the California Regional Water Quality Control Board (RWQCB) was assigned as the lead agency for the technical review of surface water and groundwater impacts. The DTSC retained authority and responsibility for technical review of all units that would not be addressed by the RWQCB or City of Berkeley. It also retained authority to review the evaluations and decisions of the other regulatory agencies, to ensure compliance with RCRA requirements.

The five primary components of the CAP are:

- RCRA Facility Assessment (RFA)
- RCRA Facility Investigation (RFI)
- Interim Corrective Measures (ICMs)
- Corrective Measures Study (CMS)
- Corrective Measures Implementation (CMI).

1.3.1 RCRA Facility Assessment

In 1991 and 1992, the DTSC (DTSC, 1991) and Berkeley Lab (Berkeley Lab, 1992a) conducted independent RCRA Facility Assessments (RFAs) to identify known and potential past releases of hazardous waste and hazardous constituents to the environment from Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) at Berkeley Lab. SWMUs, AOCs, and other areas of known or potential release are collectively referred to as "units" in this report.

A SWMU is defined as any unit at a hazardous waste facility from which hazardous constituents might migrate. "Hazardous constituent" means a constituent identified in California Code of Regulations (CCR), Title 22, Division 4.5, Chapter 11 (Identification and Listing of Hazardous Waste); or any component of a hazardous waste or leachate which has a chemical or physical property that causes the waste or leachate to be identified as a hazardous waste (CCR, Title 22, Section 66260.10).

An AOC is defined as any suspected release of a hazardous waste or hazardous constituent that is not associated with a Solid Waste Management Unit.

SWMUs identified at Berkeley Lab included primarily above-ground and underground waste storage tanks, sumps, scrap yards, plating shops, the former hazardous waste handling facility, waste accumulation areas, hazardous waste storage areas, and waste treatment units. AOCs identified at Berkeley Lab primarily included chemical product storage tanks (e.g., fuel tanks), transformers, and hazardous materials storage areas. In addition, for the purpose of identification and assessment, Berkeley Lab also designated groundwater plumes and sanitary sewer lines as AOCs.

A total of 75 SWMUs and 88 AOCs were identified during the RFAs and subsequent investigations. The RFAs found that hazardous waste or hazardous constituents had been released to soil and groundwater. Based on these findings, DTSC concluded that remedial investigations would be needed to characterize areas at the site where releases had occurred, and requested that Berkeley Lab submit a workplan for conducting a RCRA Facility Investigation (RFI) to further assess the extent of those releases.

1.3.2 RCRA Facility Investigation

Berkeley Lab submitted the RFI Work Plan to DTSC in November 1992 (Berkeley Lab, 1992b). A primary objective of the RFI, which was conducted between October 1992 and September 2000, was to collect adequate information to support corrective action decisions. To meet this objective, the RFI included identification of the source and nature of hazardous wastes and hazardous constituents that had been released to the environment, and characterization of the magnitude and extent of those releases.

Due to the complexity of the investigations needed at Berkeley Lab, the RFI was divided into three phases. RFI Phase I (Berkeley Lab 1994a) and Phase II (Berkeley Lab 1995a) Progress Reports were submitted to the DTSC in 1994 and 1995, respectively. The Draft Final RFI Report, which described the investigations conducted subsequent to the two progress reports, was submitted to the DTSC on September 29, 2000 (Berkeley Lab 2000).

The Draft Final RFI Report, which was subsequently approved as the Final RFI Report by DTSC, contained detailed information on the history, operations; adjacent land use; meteorology; utilities, ecology, physiography, geology, and hydrogeology of the site. In addition, the following detailed information was included:

- a description of the SWMUs and AOCs that were investigated
- results of contamination characterization activities that were completed
- potential and identified sources of contamination
- contaminant migration pathways
- Interim Corrective Measures (ICMs) that were implemented.

During the RFI, a screening process was implemented to determine which soil units exceeded the screening criteria and should therefore be included in the CMS because of potential risk to human health, and which units would be excluded from any further action. The former units were designated for No Further Investigation (NFI) and the latter for No Further Action (NFA). The screening process consisted of a comparison between the concentrations of chemicals detected in soil to California-modified Preliminary Remediation Goals (PRGs) and United States Environmental Protection Agency (USEPA) Region 9 PRGs (USEPA 1996a,

1998, 1999) for residential soil. Concentrations of naturally occurring inorganic elements detected in the soil were also compared to Berkeley Lab background levels. Subsequent to submittal of the Draft Final RFI Report (Berkeley Lab 2000), the DTSC requested that Berkeley Lab reevaluate the NFA-approved units to determine whether any should be reclassified as NFI based on the most recent PRGs available at that time (USEPA 2000). Two NFA-approved units were reclassified as NFI as a result of this comparison, and were subsequently included in the CMS (Berkeley Lab, 2002a). The RFI soil screening levels used for these evaluations are provided in **Appendix F**.

1.3.3 Interim Corrective Measures

During the RFI, Berkeley Lab implemented ICMs with the concurrence of the DTSC to address hazards where immediate action was required to protect human health or the environment. The ICMs primarily involved excavation and offsite disposal of contaminated soil from the areas that posed the greatest risk to human health or the environment and installation of groundwater and soil vapor extraction systems in areas where it was necessary to control the migration of contaminants. The locations of the soil excavation ICMs are listed in **Table 1.3.3-1.**

Table 1.3.3-1. Locations of Soil Excavation ICMs Implemented at Berkeley Lab

Unit Number	Unit Name
Units Included in CMS Report	
SWMU 3-6	Building 75 Former Hazardous Waste Handling and Storage Facility
AOC 1-9	Building 71 Groundwater Solvent Plume: Building 71B Lobe
AOC 2-5	Building 7 Sump
AOC 6-3	Building 88 Hydraulic Gate Unit
AOC 10-5	Building 52A Groundwater Plume Source Area
Units Not Included in CMS Report	
AOC 1-10	Building 71 Room 003 Mercury Release
AOC 5-5	Building 77 Diesel Generator Pad
AOC 9-2	Building 51 Former Diesel UST
AOC 9-9	Building 51 Sanitary Sewer and Drainage System
AOC 9-10	Building 51/64 Catch Basin
AOC 9-13	Building 51/64 Groundwater Solvent Plume
AOC 11-1	Building 74 Former Diesel UST
AOC 14-1	Building 2 Diesel UST
AOC 14-7	Building 37 Electrical Substation
SWMU 2-1	Former Building 7 Plating Shop
SWMU 2-2	Former Building 52B Abandoned Above-Ground Liquid Waste Storage Tank
SWMU 2-3	Former Building 17 Scrap Yard and Drum Storage Area
SWMU 9-4	Building 51 Vacuum Pump Room Sump and Collection Basins
SWMU 9-6	Building 51 Motor Generator Room Sump
SWMU 10-10	Building 25 Plating Shop Floordrains
not a unit	Building 51 Basement Oil Pumps

1.3.4 Corrective Measures Study

Based on results of the RFI, the DTSC determined that: 1) chemicals detected in the soil and groundwater at Berkeley Lab posed a potential threat to human health and the environment and 2) a CMS was required. As the initial step in the CMS, Berkeley Lab completed both an Ecological and a Human Health Risk Assessment (ERA and HHRA) (Berkeley Lab 2002b, 2003a).

The risk assessments estimated the potential risks to human health and the environment (plants and wildlife) from anthropogenic chemicals in soil, groundwater, sediment, and surface water at Berkeley Lab assuming that no cleanup would take place. The risk assessments consisted of the following four steps:

- Identifying the hazards associated with the chemicals of concern
- Assessing the magnitude, frequency, and duration of exposure of humans and wildlife to the chemicals
- Assessing the toxicity of the chemicals
- Estimating the potential risk.

The HHRA and ERA provided the basis for requiring further action for the soil and groundwater units, and identified the potential exposure pathways that need to be addressed. The remaining stages of the CMS, which are the subject of this report, include the identification and evaluation of potential corrective measures alternatives for the soil and groundwater units that require further action.

1.3.4.1 Ecological Risk Assessment

The Ecological Risk Assessment evaluated the potential for chemical contaminants detected in soil, sediment, surface water, and groundwater at Berkeley Lab to adversely affect the reproduction, growth, or survival of plant and wildlife individuals and populations (ecological receptors). Exposure estimates were calculated for representative terrestrial plants, terrestrial wildlife (vertebrates and invertebrates), aquatic plants, and aquatic wildlife (vertebrates and invertebrates). A description of the area within an approximately 1-mile radius of Berkeley Lab was prepared to identify any species that could potentially inhabit the site.

Special species evaluated included California species of special concern; state and federally listed rare, threatened, or endangered species; and species that were proposed or recommended for state or federal listing. No special status plant or animal species were identified at Berkeley Lab; however, one special status species known to occur within 5 miles of the lab, the Cooper's hawk was retained in the ERA as an individual predatory organism whose exposure could be significant for chemicals with a high biomagnification potential (Berkeley Lab, 2002b).

Direct exposure to most soils and groundwater within the central developed area of Berkeley Lab were eliminated as completed exposure pathways in the ERA because suitable habitat for wildlife, is restricted to the natural, perimeter areas of Berkeley Lab, and is not

present in the central developed area. The ERA concluded that no hazards exist to plants or animals from exposure to chemicals in soil, groundwater, or surface water at Berkeley Lab. The DTSC approved the ERA on April 14, 2003 (DTSC, 2003a)

1.3.4.2 Human Health Risk Assessment

The HHRA (Berkeley Lab, 2003a) identified the current and reasonably likely future land use at Berkeley Lab as industrial-type institutional land use. The potential receptors and exposure routes for the institutional land-use scenario were described in detail in the HHRA. The activities associated with institutional land use are described in Section 1.2 of this report. The potential receptors associated with this land-use scenario are Berkeley Lab employees (laboratory workers, office workers, and outdoor workers such as landscape maintenance workers) and construction workers.

The HHRA also evaluated a hypothetical future residential land use scenario that included on-site residents and recreational users as potential receptors. The Residential scenario was included for informational purposes only. Off-site human receptors (i.e., local residents) were not evaluated in the HHRA because there are no complete exposure pathways to those individuals and none is anticipated in the future. There are no complete exposure pathways to potential offsite receptors from groundwater pathways because the groundwater plumes at Berkeley Lab have not migrated beyond the site boundary and are stable (Berkeley Lab, 2000). The stability of the plumes is indicated by measured groundwater concentrations that are generally static or decreasing throughout the plume areas and by the long-term absence of detectable concentrations of contaminants in wells monitoring the areas downgradient from the plumes.

Based on the RFI soil screening process described above, DTSC determined that 15 soil SWMUs and 12 soil AOCs should be evaluated in the HHRA. In addition, two undesignated areas of soil contamination that did not pass the screening process (Building 51L Groundwater Plume Source Area and Slope West of Building 53) were retained for evaluation in the HHRA. All areas where chemicals were detected in groundwater or surface water (i.e., groundwater units and surface water units) were also addressed in the HHRA. The SWMUs, AOCs, and other locations that were included in the HHRA are listed in **Table 1.3.4-1**. The Module designations given in the table correspond to designations given in the RFI report (Berkeley Lab, 2000).

Table 1.3.4-1. List of SWMUs, AOCs, and Other Areas Evaluated in the HHRA

Berkeley Lab Unit Name	Berkeley Lab Unit Number	DTSC[a] Unit Number	Oversight Agency
SOIL UNITS			
Bevalac Area			
Building 51 Vacuum Pump Room Sump and Collection Basins	SWMU 9-4	SWMU-1	DTSC
Building 51 Motor Generator Room Sump	SWMU 9-6	—	DTSC
Building 51 Sanitary Sewer and Drainage System	AOC 9-9	—	DTSC
Buildings 51/64 Former Temporary Equipment Storage Area	AOC 9-12	—	DTSC
Building 51L Groundwater Plume Source Area	—	—	DTSC
Old Town Area			
Building 7 Former Plating Shop	SWMU 2-1	—	DTSC
Building 52B Abandoned Liquid Waste Above Ground Storage Tank (AST) and Sump	SWMU 2-2	SWMU-4	DTSC
Building 17 Former Scrap Yard and Drum Storage Area	SWMU 2-3	SWMU-11	DTSC
Building 16 Former Waste Accumulation Area	SWMU 10-4	SWMU-9	DTSC
Building 25 Plating Shop Floor Drains	SWMU 10-10	—	DTSC
Building 7E Former Underground Storage Tank (UST)	AOC 2-1	AOC-4	COB[b]
Building 7 Former Hazardous Materials Storage Area	AOC 2-2	—	DTSC
Building 7 Sump	AOC 2-5	—	DTSC
Building 46 Hazardous Materials Storage Area	AOC 7-3	—	DTSC
Building 58 Former Hazardous Materials Storage Area	AOC 7-6	—	DTSC
Building 52 Former Hazardous Materials Storage Area	AOC 10-2	—	DTSC
Building 37 Proposed Electrical Substation	AOC 14-7	—	DTSC
Slope West of Building 53	—	—	DTSC
Support Services Area			
Building 69A Former Hazardous Materials Storage and Delivery Area	SWMU 3-1	SWMU-15	DTSC
Building 69A Storage Area Sump	SWMU 3-5	—	DTSC
Building 75 Former Hazardous Waste Handling and Storage Facility	SWMU 3-6	—	DTSC

Table 1.3.4-1. List of SWMUs, AOCs, and Other Areas Evaluated in the HHRA (cont'd.)

Berkeley Lab Unit Name	Berkeley Lab Unit Number	DTSC[(a)] Unit Number	Oversight Agency
SOIL UNITS (cont'd.)			
Support Service Area (cont'd.)			
Building 76 Motor Pool and Collection Trenches and Sump	SWMU 4-3	SWMU-29	DTSC
Building 76 Present and Former Waste Accumulation Area #3	SWMU 4-6	SWMU-35	DTSC
Building 77 Plating Shop	SWMU 5-4	SWMU-30	DTSC
Building 77 Former Yard Decontamination Area	SWMU 5-10	—	DTSC
Module D: Outlying Areas			
Building 50 Inactive Underground Residual Photographic Solution Storage Tank (TK-09-50)	SWMU 12-1	SWMU-5	COB
Building 88 Hydraulic Gate Unit	AOC 6-3	AOC-2	DTSC
Building 58/Building 70 Sanitary Sewer	AOC 8-6	—	DTSC
Building 62 Hazardous Materials Storage Area	AOC 13-1	—	DTSC
GROUNDWATER UNITS			
Bevalac Area			
Building 71 Groundwater Solvent and Freon Plumes	AOC 1-9	—	RWQCB[(c)]
Buildings 51/64 Groundwater Plume	AOC 9-13	—	RWQCB
Building 51L Groundwater Plume	—	—	RWQCB
Old Town Area			
Old Town Groundwater Solvent Plume (Buildings 7 Lobe)	AOC 2-4	—	RWQCB
Solvent-Contaminated Groundwater in Area 10 (Building 25A Lobe of the Old Town Groundwater Solvent Plume)	AOC 10-5	—	RWQCB
Solvent-Contaminated Groundwater in Area 10 (Building 52 Lobe of the Old Town Groundwater Solvent Plume)	AOC 10-5	—	RWQCB
Well MWP-7 Groundwater Contamination	AOC 14-5	—	RWQCB

Table 1.3.4-1. List of SWMUs, AOCs, and Other Areas Evaluated in the HHRA (cont'd.)

Berkeley Lab Unit Name	Berkeley Lab Unit Number	DTSC[(a)] Unit Number	Oversight Agency
GROUNDWATER UNITS (cont'd.)			
Support Services Area (cont'd.)			
Solvents in Groundwater South of Building 76	AOC 4-5	—	RWQCB
Building 69A Area	—	—	RWQCB
Building 75/75A Area	—	—	RWQCB
Building 75B Area	—	—	RWQCB
Building 77 Area	—	—	RWQCB
Benzene Detected in Two Wells East of Building 75A	—	—	RWQCB
SURFACE WATER UNITS			
Site-Wide Contaminated Hydrauger Discharges (Buildings 51 and 77 areas)	AOC SW1	AOC-8	RWQCB
Surface Water (Creeks and Building 71 spring)	—	—	RWQCB

(a) DTSC: California Environmental Protection Agency, Department of Toxic Substances Control.
(b) COB: City of Berkeley Planning and Development Department, Toxics Management Division.
(c) RWQCB: San Francisco Bay Region Regional Water Quality Control Board.

The HHRA estimated the theoretical incremental lifetime cancer risks (ILCRs) and non-cancer health hazards for on-site workers that could potentially be exposed to anthropogenic chemicals in soil, groundwater, and surface water at Berkeley Lab. The theoretical ILCRs and non-cancer Hazard Indices (HIs)were evaluated relative to the following two risk comparators to determine which units should be retained in the CMS: 1) the USEPA-recommended risk management range (i.e., a theoretical ILCR between 10^{-6} and 10^{-4}) also referred to as the "risk management range" and 2) a non-cancer HI of 1. The risk management range of 10^{-4} to 10^{-6} is considered by the USEPA to be safe and protective of public health (Federal Register 56(20): 3535, Wednesday, January 30, 1991). Exposure to chemicals with an HI below 1.0 is considered unlikely to result in adverse non-cancer health effects over a lifetime of exposure. Risk levels below these two criteria are generally considered by regulatory agencies to be *de minimis* levels. The theoretical ILCRs and HIs provided data necessary to support the development of

appropriate corrective actions, or at units where there was a very low level of risk or hazard, a recommendation that no remedial action should be required.

In addition to comparison to risk-based levels, the HHRA also considered promulgated standards and regulatory policies when recommending which units should be retained in the CMS. Groundwater is not used for drinking or other domestic water supply at Berkeley Lab (or in the City of Berkeley) and water for domestic use will likely be supplied to the Lab and Berkeley residents by the East Bay Municipal Utility District (EBMUD) for the foreseeable future. Thus, exposure to chemicals in groundwater via water ingestion or other domestic use was not evaluated in the risk assessment. Although groundwater is not used for domestic supply at Berkeley Lab, potential impacts to the beneficial use of groundwater were evaluated in the HHRA. State Water Resources Control Board (SWRCB) Resolution No. 88-63, "Sources of Drinking Water" specifies that except under specifically identified circumstances, all surface waters and groundwaters are to be protected as existing or potential sources of municipal and domestic supply.

The HHRA concluded that four areas of soil contamination and eleven areas of groundwater contamination posed a potential risk to human health and/or beneficial uses of groundwater, and therefore should be retained for further evaluation in subsequent parts of the CMS. These 15 units are listed in **Table 1.3.4-2** (soil units) and **Table 1.3.4-3** (groundwater units) along with the following information:

- A notation as to whether the unit was retained in the CMS based on risk or regulatory policy.
- For the units included in the CMS based on potential risk, the exposure pathways and the corresponding human receptors of potential concern.

Table 1.3.4-2. Soil Units Recommended to be Retained in Corrective Measures Study in the Human Health Risk Assessment (Berkeley Lab, 2003a)

Unit	Retained in CMS Based on Regulatory Policy[a]	Retained in CMS Based on Risk[b]	Risk-Based Chemicals of Concern[e]	Soil Exposure Pathway of Potential Concern [b][c]	Potential Receptor of Concern[b]
MODULE A: BEVALAC AREA					
Building 51L Groundwater Plume Source Area	yes	yes	chloroform **vinyl chloride** **1,1-DCE** **TCE** carbon tetrachloride 1,2-DCA	I	Potential Future Indoor Worker
MODULE B: OLD TOWN AREA					
AOC 2-5: Former Building 7 Sump	yes	yes	**carbon tetrachloride** **PCE** TCE	I I	Potential Future Indoor Worker Landscape Worker
MODULE C: SUPPORT SERVICES AREA					
SWMU 3-6: Building 75 Former Hazardous Waste Handling and Storage Facility	no	yes	**PCBs**[d]	F[d], D[d] F[d], D[d]	Landscape Worker[d] Construction Worker[d]
MODULE D: OUTLYING AREAS					
AOC 6-3: Building 88 Hydraulic Gate Unit	no	yes	**PCBs**[d]	I[d], F[d], D[d] F[d], D[d]	Landscape Worker[d] Construction Worker[d]

(a) SWRCB Resolution 88-63 (Sources of Drinking Water Policy)

(b) Theoretical Incremental Lifetime Cancer Risks equaled or exceeded 10^{-6} or non-cancer Hazard Indices (HIs) equaled or exceeded 1.0.

(c) I:Inhalation, F:Ingestion, D:Dermal Contact

(d) ICMs completed in 2003 or 2004 (excavation and offsite disposal of PCB-contaminated soil) reduced risks below levels of concern (to levels consistent with unrestricted land use). No further action is proposed for these units.

(e) Theoretical incremental lifetime cancer risk equaled or exceeded 10^{-6} or non-cancer Hazard Quotient equaled or exceeded 1. Boldface type indicates primary chemical(s) that contribute to the estimated risk.

Table 1.3.4-3. Groundwater Units Recommended to be Retained in Corrective Measures Study in the Human Health Risk Assessment

Unit	Retained in CMS Based on Regulatory Policy[a]	Retained in CMS Based on Risk[b]	Risk-Based Chemicals of Concern[d]	Groundwater Exposure Pathway of Potential Concern[b][c]	Potential Receptor of Concern[b]
MODULE A: BEVALAC AREA					
AOC 9-13: Building 51/64 Groundwater Solvent Plume	yes	yes	**1,1-DCA** **vinyl chloride** carbon tetrachloride TCE	I	Potential Future Indoor Worker
Building 51L Groundwater Solvent Plume	yes	yes	**vinyl chloride** TCE	I	Potential Future Indoor Worker
AOC 1-9: Building 71 Groundwater Solvent Plume Building 71B lobe	yes	yes	**vinyl chloride**	I	Potential Future Indoor Worker
MODULE B: OLD TOWN AREA					
AOC 2-4: Building 7 Lobe of the Old Town Groundwater Solvent Plume	yes	yes	**carbon tetrachloride** **PCE** TCE vinyl chloride	I D	Potential Future Indoor Worker Construction Worker
AOC 10-5: Building 52 Lobe of the Old Town Groundwater Solvent Plume	yes	yes	**carbon tetrachloride** chloroform	I	Potential Future Indoor Worker
AOC 10-5: Building 25A Lobe of the Old Town Groundwater Solvent Plume	yes	yes	(e)	(e)	(e)
MODULE C: SUPPORT SERVICES AREA					
AOC 4-5: Solvents in Groundwater South of Building 76	yes	no			
Support Services Area (Building 69A Area)	yes	yes	**vinyl chloride**	I	Potential Future Indoor Worker

Unit	Retained in CMS Based on Regulatory Policy[a]	Retained in CMS Based on Risk[b]	Risk-Based Chemicals of Concern[d]	Groundwater Exposure Pathway of Potential Concern[b][c]	Potential Receptor of Concern[b]
MODULE C: SUPPORT SERVICES AREA (cont'd.)					
Support Services Area (Building 75/75A Area)	yes	no			
Support Services Area (Building 77 Area)	yes	no			
Benzene Detected in Wells East of Building 75A	yes	no			

(a) SWRCB Resolution 88-63 (Sources of Drinking Water Policy). Note the Human Health Risk Assessment (HHRA) did not include an evaluation of well yield when recommending areas of groundwater contamination to be retained in the CMS based on regulatory policy.

(b) Theoretical ILCRs to one or more receptors equaled or exceeded 10^{-6} or non-cancer Hazard Indices (HIs) equaled or exceeded 1.0

(c) I:Inhalation, F:Ingestion, D:Dermal Contact

(d) Theoretical incremental lifetime cancer risk equaled or exceeded 10^{-6} or non-cancer Hazard Quotient equaled or exceeded 1. Boldface type indicates primary chemical(s) that contribute to the estimated risk. Note that the Chemicals of Concern in the HHRA differ from those in the CMS Report due to updates in the risk evaluations.

(e) A revised risk estimate based on USEPA withdrawal of the cancer potency factor for 1,1-DCE indicates there are no risk-based COCs for this unit (Appendix C of the HHRA).

The HHRA recommended no additional investigation or remedial action to address human health issues associated with surface water at Berkeley Lab. Theoretical ILCRs for exposure to COCs in surface water were below the USEPA risk management range ($<10^{-6}$) and the non-cancer HI was less than 1, for all surface water units except for effluent from the Building 51 hydraugers. However, the theoretical ILCRs from the hydrauger effluent only marginally exceed the 10^{-6} level, and there is no exposure pathway since the hydrauger effluent is piped to a groundwater treatment system where it has been collected and treated to non-detectable contaminant levels for the past 12 years. The treated hydrauger effluent has been discharged to the sanitary sewer under conditions of Berkeley Lab's Wastewater Discharge Permit issued by the East Bay Municipal Utility District (EBMUD).

The HHRA also evaluated potential adverse effects to human health based on a hypothetical future restricted residential use scenario. The receptors evaluated under this

scenario included on-site future hypothetical residents and recreational users (recreationists). The theoretical ILCRs and non-cancer HIs presented under this scenario in the HHRA would be appropriate (for screening purposes) only if the institutional land use status for Berkeley Lab were to be changed to residential land use.

The DTSC accepted the HHRA on August 19, 2003 (DTSC, 2003b). The acceptance was conditional, pending a final approval determination after the CMS Report has been submitted and a formal public comment period has been held on the proposed remedy selection.

1.3.4.3 Screening, Evaluating, and Selecting Corrective Measures Alternatives

This CMS Report identifies and screens potential corrective measures alternatives for the soil and groundwater units that require further action based on the results of the HHRA. It also recommends which alternative should be implemented at each unit based on a comprehensive evaluation process that was described in the CMS Plan (Berkeley Lab, 2002a). DTSC will evaluate the results and recommendations of the CMS Report and select the specific corrective measures that Berkeley Lab will implement.

1.3.4.4 Community Involvement in the CMS Process

After the CMS has been completed, the DTSC will prepare a Statement of Basis for the selected remedies. The public will be invited to comment on the proposed remediation decisions at that time, including the corrective measures that are proposed for implementation and the MCS that should be achieved. In addition, the public will be invited to comment on the California Environmental Quality Act (CEQA) initial study to evaluate the environmental effects of the selected remedies at that time. After consideration of the public comments, the DTSC will respond to the comments; approve the CMS Report and final remedy selection, if appropriate; and issue a Modified Hazardous Waste Handling Facility Permit.